Sources of the brain activation in visual attention: a novel feature for electroencephalography-based brain computer interface

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Publication date:
2014

Document Version
Publisher's PDF, also known as Version of record

When citing an abstract from the 2014 annual meeting please use the format below.

[Authors]. [Abstract Title]. Program No. XXX.XX. 2014 Neuroscience Meeting Planner. Washington, DC: Society for Neuroscience, 2014. Online.

None. **G. Di Pino:** None. **D. Camboni:** None. **M. Carrozza:** None. **E. Guglielmelli:** None. **P. Rossini:** None. **U. Faraguna:** None.

Poster

165. Neural Decoding

Location: Halls A-C

Time: Sunday, November 16, 2014, 8:00 AM - 12:00 PM

Program#/Poster#: 165.15/II24

Topic: D.18. Brain-Machine Interface

Support: Department of Electrical Engineering, Technical University of Denmark

Grant of excellence (Mapping & Modeling the Control of Action; Lundbeck foundation)

Radiometer, Denmark

Title: Sources of the brain activation in visual attention: A novel feature for electroencephalography-based brain-computer interface

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Abstract: For the past two decades, the research on the electroencephalography (EEG)-based brain-computer interface (BCI) has been growing exponentially. In the field of attention, the main aim of BCI is to restore and replace the functional disability of the brain in focusing of attention. BCI uses the patterns (features) of healthy brain functions as a template to detect the functional deviations. Therefore, feature selection plays a key role in the performance of the system, resulting in failed/unwanted outcomes otherwise. This study has focused on extracting attention-related features based on source analysis of neural activities. In this pilot study, a total of seven volunteers (2 females) with the average age of 28.7±2.4 participated in this study. The subjects were instructed to perform a visual paradigm (consisted of one central square where the cues were demonstrated and two side squares require to be attended to) designed to measure the covert or overt attention. The design of the paradigm was based on the steady-state visual evoked potential meaning that the side squares were flickering in different frequencies (6, 7, 8 and 9 Hz) in each trial. Subjects were instructed to attend covertly or overtly to the flickering objects. Data

was collected by a 128-channel EEG setup (sampled at 512Hz). The data were band-pass (2-45Hz) filtered and the epochs were extracted between 2-13s after the central cue. The data was then decomposed into their maximally independent components (IC) by independent component analysis (ICA). An equivalent current dipole model was used as an analysis method to demonstrate the topography of each IC. The focus was on extracting the brain responses to the flickering frequencies in covert and overt attention. Results showed that in the components corresponding to overt attention, the occipital and parietal regions are involved; whereas, in covert attention, the frontal area contributed significantly. These results suggested that covert and overt attentions recruit different brain areas. Findings from this pilot study indicate that the covert attention might be controlled by frontal cortex in order to gate the input signals. On the other hand, in overt attention primary visual cortex and frontal eye field are mostly involved. Such characteristics can be an interesting and perhaps a novel feature for the BCI system for covert visual attention in order to dissociate the covert attention.

Disclosures: M. Ordikhani-Seyedlar: None. **H.B.D. Sorensen:** None. **T.W. Kjaer:** None. **S. Puthusserypady:** None.